Stoller
Hanford Office
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HGLP-LDR-065

299-W18-182 (A7664)
Log Data Report

Borehole Information:

Borehole:	299-W18-182 (A7664)		**Site:**	216-Z-12 Crib	
Coordinates (WA St Plane)		**GWL[1] (ft) :**	None	**GWL Date:**	03/26/07
North (m)	**East (m)**	**Drill Date**	**TOC Elevation**	**Total Depth (ft)**	**Type**
135433.65	566364.064	05/80	686.98	40	Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	0	6 9/16	6 1/16	1/4	0	40

Borehole Notes:

Because of damage to the casing above ground, it was cut approximately 2.5-in. below ground surface. The casing removed was 2.65 ft in length. Thus, measurements are referenced to the ground surface and must be adjusted approximately 2.40 ft to reflect the elevation reported in the table above. The logging engineer measured the casing diameter using a caliper and steel tape.

According to the driller's log, a grout plug was placed in the bottom of the borehole from 38 to 40 ft and outside the 6-in. casing from ground surface to 15 ft.

Logging Equipment Information:

Logging System:	Gamma 1N		**Type:**	SGLS (60%) SN: 45-TP22010A
Effective Calibration Date:	02/20/07	**Calibration Reference:**	HGLP-CC-010	
		Logging Procedure:	HGLP-MAN-002, Rev. 0	

Logging System:	Gamma 2H/with source		**Type:**	NMLS SN: H310700352
Effective Calibration Date:	11/28/06	**Calibration Reference:**	HGLP-CC-006	
		Logging Procedure:	HGLP-MAN-002, Rev. 0	

Logging System:	Gamma 4H/without source		**Type:**	PNLS SN: H310700352
Effective Calibration Date:	11/28/06	**Calibration Reference:**	HGLP-CC-006	
		Logging Procedure:	HGLP-MAN-002, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2 Repeat	3 Repeat		
Date	03/26/07	03/26/07	03/27/07		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	36.5	35.5	34.5		
Finish Depth (ft)	0.5	33.5	17.5		
Count Time (sec)	100	800	800		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
ft/min	N/A[2]	N/A	N/A		
Pre-Verification	AN050CAB	AN050CAB	AN051CAB		
Start File	AN050000	AN050037	AN051000		

Log Run	1	2 Repeat	3 Repeat		
Finish File	AN050036	AN050039	AN051017		
Post-Verification	AN050CAA	AN050CAA	AN051CAA		
Depth Return Error (in.)	0	0	0		
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.		

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	4	5 Repeat			
Date	03/28/07	03/28/07			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	37.0	26.5			
Finish Depth (ft)	0.25	16.5			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
Sample Interval (ft)	0.25	0.25			
ft/min	N/A	N/A			
Pre-Verification	BH004CAB	BH004CAB			
Start File	BH004000	BH004148			
Finish File	BH004147	BH004188			
Post-Verification	BH004CAA	BH004CAA			
Depth Return Error (in.)	0	0			
Comments	None	None			

Passive Neutron Logging System (PNLS) Log Run Information:

Log Run	6	7 Repeat			
Date	03/28/07	03/28/07			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	37.0	35.5			
Finish Depth (ft)	0.25	17.5			
Count Time (sec)	15	60			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
ft/min	N/A	N/A			
Pre-Verification	BH005CAB	BH005CAB			
Start File	BH005000	BH005148			
Finish File	BH005147	BH005166			
Post-Verification	BH005CAA	BH005CAA			
Depth Error (in.)	- 1.0	0			
Comments	None	None			

Logging Operation Notes:

Logging was conducted with a centralizer on each sonde and measurements are referenced to ground surface. Repeat data with the SGLS were acquired at an 800 second counting time from 17.5 to 34.5 ft to provide additional detail of the highest activity zone. Because the repeat data acquired at 800 seconds are statistically more reliable than data acquired at 100 seconds, the repeat data are plotted as the main logs.

The NMLS and PNLS data are acquired with the same sonde, with an AmBe source and without, respectively.

Analysis Notes:

Analyst:	Henwood	Date:	04/19/07	Reference:	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for the logging systems were performed before and after each day's data acquisition. The acceptance criteria were met.

A casing correction for 1/4-in.-thick casing was applied throughout the borehole for the SGLS.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G1NFeb07.xls using an efficiency function and corrections for casing and dead time as determined from annual calibrations. The NMLS count rate data were converted to volumetric moisture according to calibration data for a 6-in. borehole. The passive neutron logging system data are used for qualitative purposes and does not require a calibration.

Results and Interpretations:

^{241}Am is detected from 17.5 to 22.5 ft. The maximum concentration is measured at approximately 1,975,000 pCi/g at 20.5 ft. Gamma rays at approximately 662, 722, and 208 keV were detected that represent ^{241}Am. ^{137}Cs emits a 661.66 gamma ray that cannot be distinguished from the 662.40 gamma ray emitted from ^{241}Am. The energy peak at 722.01 keV is used to establish the presence of ^{241}Am rather than ^{137}Cs. In this borehole the 722.01 keV energy peak is used to determine the ^{241}Am concentration. When comparing the assays for ^{241}Am using the 662 and 722 keV energy peaks, there appears to be residual counts in the 662 keV energy peak that may be attributed to ^{137}Cs. On the basis of the 722.01 keV assay, counts from the 662.40 keV energy peak were subtracted which yields the approximate contribution from ^{137}Cs.

Using this approach, ^{137}Cs is detected from 17.5 to 30.5 ft. The maximum concentration of 220 pCi/g is measured at approximately 23.5 ft.

The ^{241}Am concentrations derived from the 208.01 keV gamma line are significantly over estimated. A 208.000 keV gamma line that results from the decay of ^{237}U (daughter of ^{241}Pu), interferes with the 208.01 keV gamma line caused by the decay of ^{241}Am. For purposes of this report, it is assumed that all of the counts in the 208 keV energy peak that cannot be attributed to ^{241}Am, reflect decay of ^{237}U. Assuming the waste stream is aged (e.g., 40 years or more), ^{237}U has grown into equilibrium with its parent ^{241}Pu. After subtracting the influence of ^{241}Am from the 208 keV energy peak, it is estimated ^{241}Pu exists from 19.5 to 21.5 ft at a maximum concentration of approximately 3,890,000 pCi/g; the maximum concentration is at 20.5 ft in depth.

^{237}Np is detected with the SGLS by measuring a daughter product (protactinium-233 (^{233}Pa)) that emits a prominent gamma ray at an energy of 312.17 keV. ^{233}Pa was detected from 17.5 to 30.5 ft. The maximum concentration is approximately 36 pCi/g at a 20.5 ft depth.

^{239}Pu was detected in this borehole. Gamma energy peaks normally used to quantify ^{239}Pu at 375.05 and 413.71 keV had interference from gamma rays at 376.65 keV (^{241}Am), 375.45 keV (^{233}Pa), 415.88 keV (^{241}Am), and 415.76 keV (^{233}Pa). After comparison of assays for each radionuclide using these energy peaks, it was determined the 413.71 keV gamma ray best represented the ^{239}Pu concentration. The approximate 414 keV energy peak was detected from 17.5 to 21.5 ft and from 25.5 to 30.5 ft. It was determined that only the interval from 17.5 to 21.5 ft actually represented ^{239}Pu. The 129.3 keV gamma ray originating from ^{239}Pu was observed in this interval. This energy peak is out of the calibration range for the SGLS (186 to 2615 keV). However, it provides corroborating evidence that ^{239}Pu exists. Where the 414 keV peak was detected from 25.5 to 30.5 ft, it was determined the 415.76 keV gamma ray from ^{233}Pa was the dominant influence; the 129 keV gamma ray or other corroborating energy peaks were not observed at this depth interval. The maximum concentration was measured at 19.5 ft at approximately 1,330,000 pCi/g.

An elevated ^{232}Th concentration as determined using the 2615 keV (^{208}Tl) energy peak, is indicated from 17.5 to 32.5 ft. The plot of natural gamma logs shows the disruption of the equilibrium of the natural ^{232}Th decay, where the ^{228}Ac (911.20 keV) indicates ^{232}Th concentrations below that calculated from the ^{208}Tl (2615 keV) gamma line. This difference is attributed to the existence of ^{232}U. To determine the concentration of ^{232}U, the activity due to natural decay of ^{232}Th must be subtracted. The ^{228}Ac concentrations based on the 911.20 keV gamma line are subtracted from the ^{232}Th concentrations calculated based on the 2615 keV ^{208}Tl energy peak. The result is a concentration range from 0.1 to 0.9 pCi/g ^{232}U.

^{233}U almost certainly exists where ^{232}U is detected. In a reactor using thorium target material, ^{233}U will be generated at two to three orders of magnitude more than ^{232}U. At relatively low concentrations, ^{233}U generally does not emit a gamma ray that can be detected with the SGLS. Decay products that potentially could be measured, have not had sufficient time to grow into equilibrium with their parent so that detection is possible. However, in this borehole a 440.42 keV gamma ray emitted by ^{213}Bi, a daughter of ^{233}U, was detected at 24.5 ft which coincides with the depth of highest ^{232}U concentration. If the ^{233}U is assumed to have aged approximately 40 years since created, the current assay of ^{213}Bi (0.45 pCi/g) predicts an initial ^{233}U concentration of approximately 4500 pCi/g.

Passive neutron logging was performed in the borehole. This logging method has been shown to be effective in qualitatively detecting zones of alpha-emitting contaminants from secondary neutron flux generated by the (α,n) reaction and may indicate the presence of α-emitting nuclides, including transuranic radionuclides, even where no gamma emissions are available for detection above the MDL. The passive neutron signal depends on the concentration of α sources, and also the concentrations of lighter elements such as N, O, F, Mg, Al, and Si which emit neutrons after alpha capture. The passive neutron log indicated a maximum count rate of approximately 28 counts per second (cps) at 20.5 ft.

A reaction ^{19}F (α,n) ^{22}Na yields a gamma ray at 1274.53 keV and a positron at 511 keV. A 1274.44 keV gamma ray also occurs from the decay of ^{154}Eu. However, there are no corroborating peaks for the ^{154}Eu and the gamma ray is attributed to the fluorine reaction. The half life of ^{22}Na is short (i.e., 2.6 years), but it will continue to be produced as long as sufficient fluorine and alpha activity exist. The ^{22}Na was detected from 18.5 to 23.5 ft at similar depth intervals as the relatively high neutron flux detected by the passive neutron logging system. The maximum concentration of ^{22}Na is approximately 2 pCi/g at 20.5 ft. The 1274 keV energy peak may also be influenced by a prompt gamma ray induced by alpha particles interacting with ^{19}F. Other energy peaks observed in the spectra that could be attributed to reactions with ^{19}F include ones at approximately 196, 583, 890, and 1236 keV. The existence of these gamma rays strongly suggest that at least some of the identified alpha emitting radionuclides are present as a fluoride.

Other energy peaks are observed in the high neutron flux intervals that represent capture gamma rays from elements in the formation, steel casing, or the waste stream itself. Gamma rays detected and possible sources include a 2223.2-keV H capture γ-ray, ^{28}Al(n,g) at 1779 keV or ^{25}Mg (α,n) at 1779 keV, ^{56}Mn at 846.75 keV and 1810.72 keV.

The naturally occurring radionuclides (KUT) and moisture data reflect grout in the upper 15 ft of the borehole. Other variations are due to sediment changes.

A comparison plot of 1998 RLS (Waste Management Federal Services NW) spectral gamma data and 2007 SGLS data is included. There is generally good agreement in the assays for ^{237}Np, ^{241}Am, ^{239}Pu, and ^{137}Cs. The RLS analysis identified a "thorium disequilibrium" condition. Current analysis suggests this disequilibrium is an indication of ^{232}U.

The SGLS, NMLS, and PNLS repeat logs all show good repeatability.

List of Log Plots:

Depth Reference is ground surface
Depth Scale - 20 ft/inch except for repeat logs

Manmade Radionuclides
Natural Gamma Logs
Combination Plot (20 ft/inch)
Combination Plot (10 ft/inch)
Total Gamma, Neutron Moisture, & Passive Neutron
SGLS/RLS Comparison of Manmade Radionuclides
Repeat of Manmade Radionuclides
Repeat Section of Total Gamma, Neutron Moisture, & PN

[1] GWL – groundwater level

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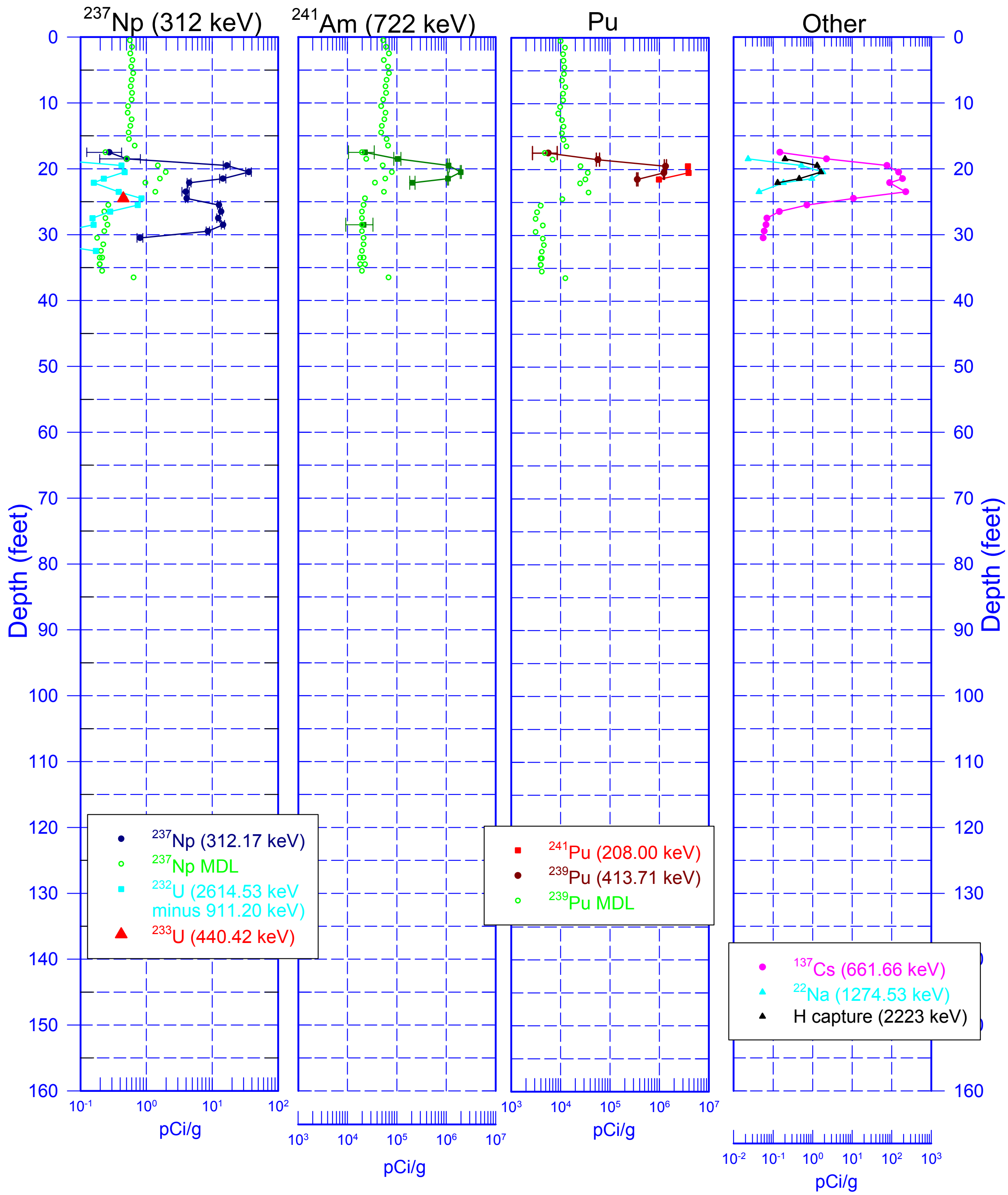
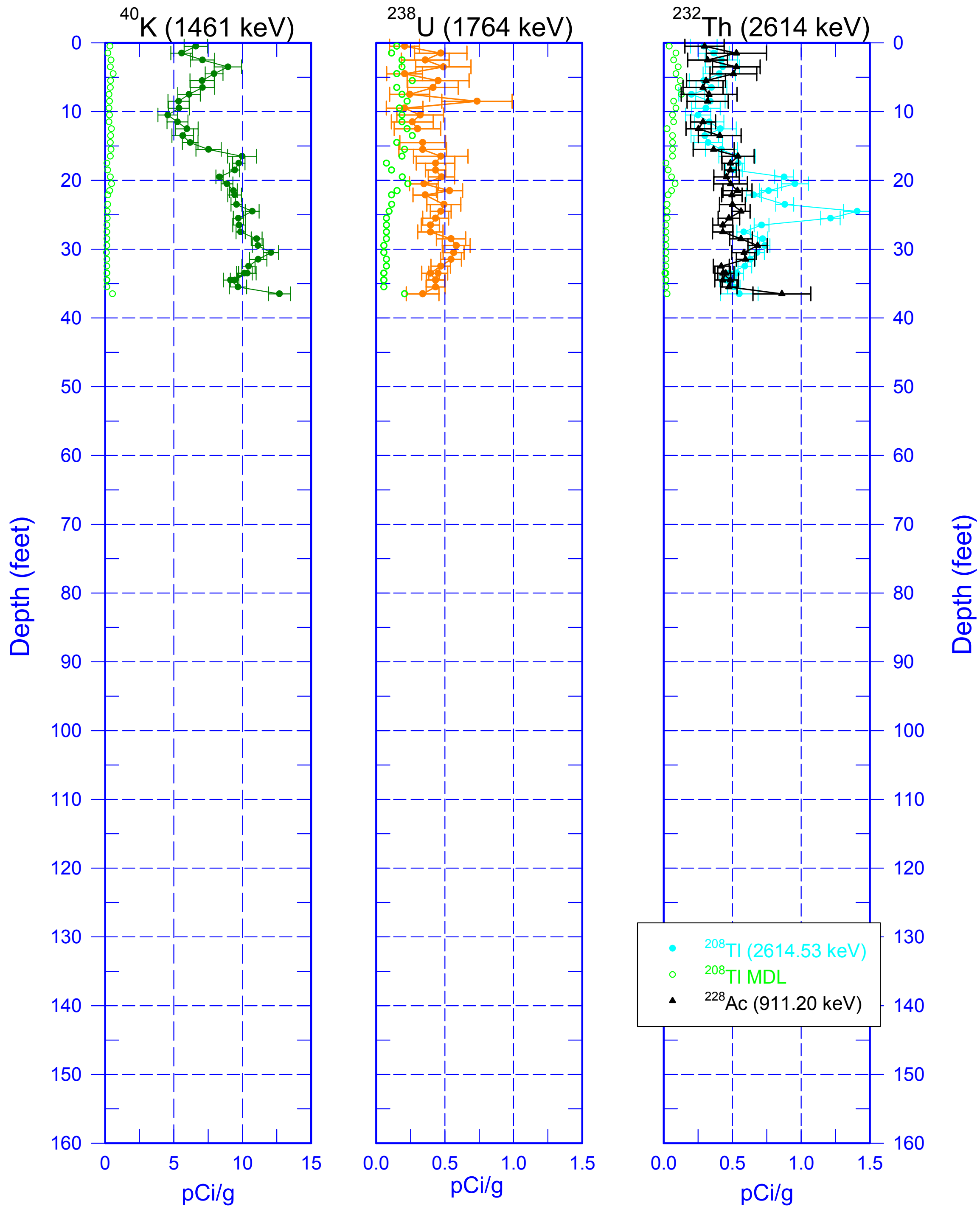
Manmade Radionuclides

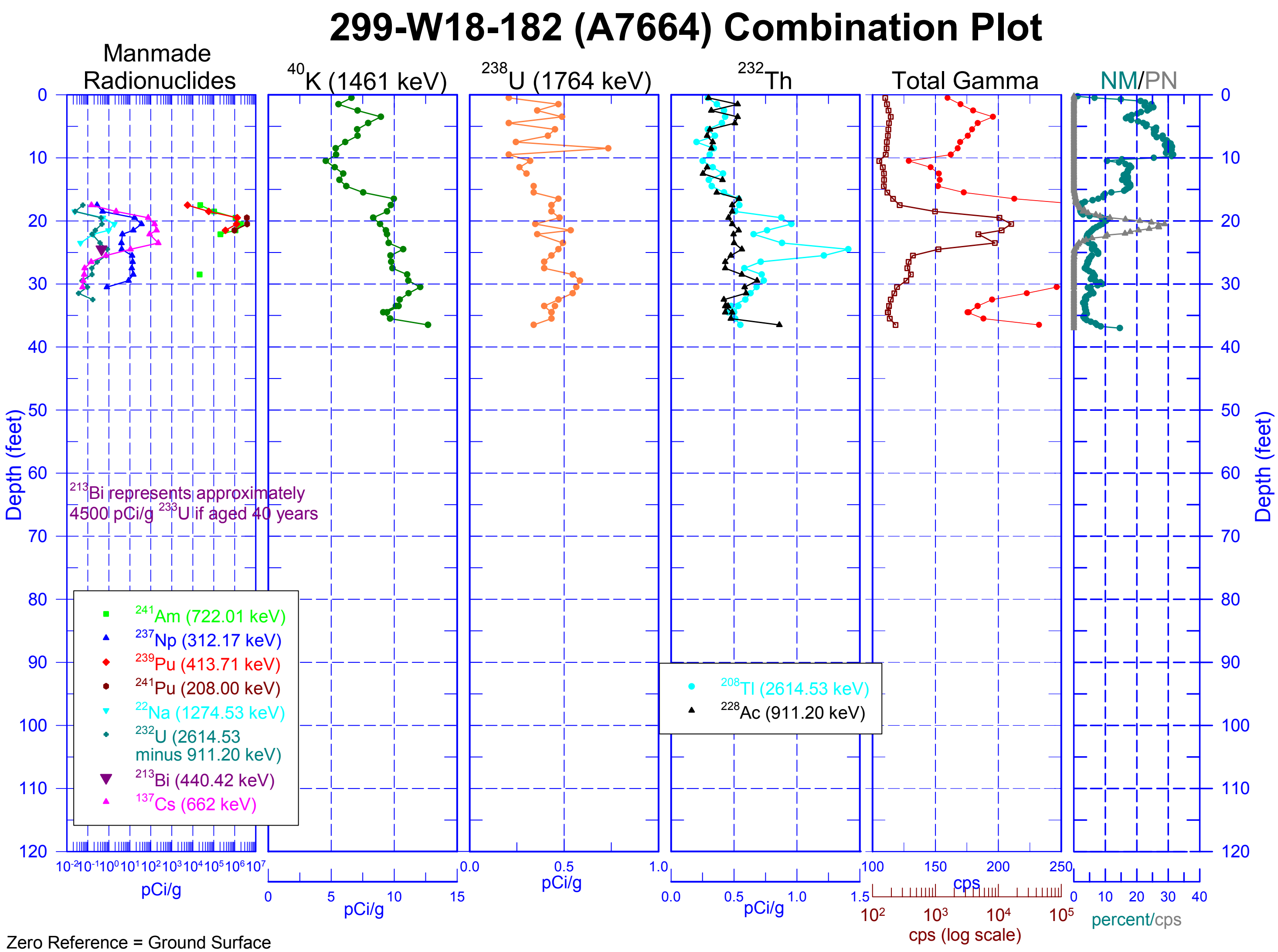


Zero Reference = Ground Surface

299-W18-182 (A7664)
Natural Gamma Logs

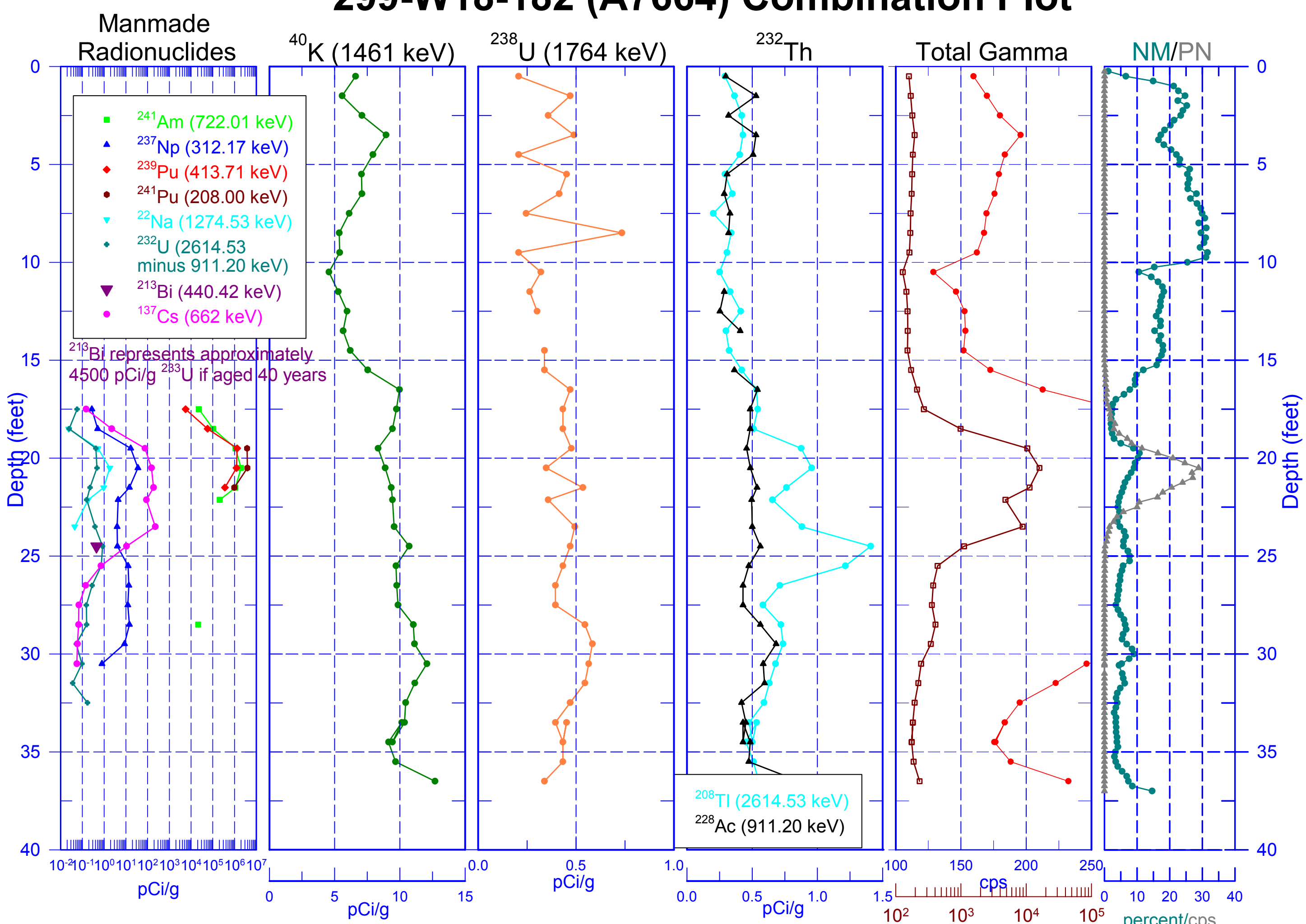


Zero Reference = Ground Surface



Zero Reference = Ground Surface

299-W18-182 (A7664) Combination Plot



Zero Reference = Ground Surface

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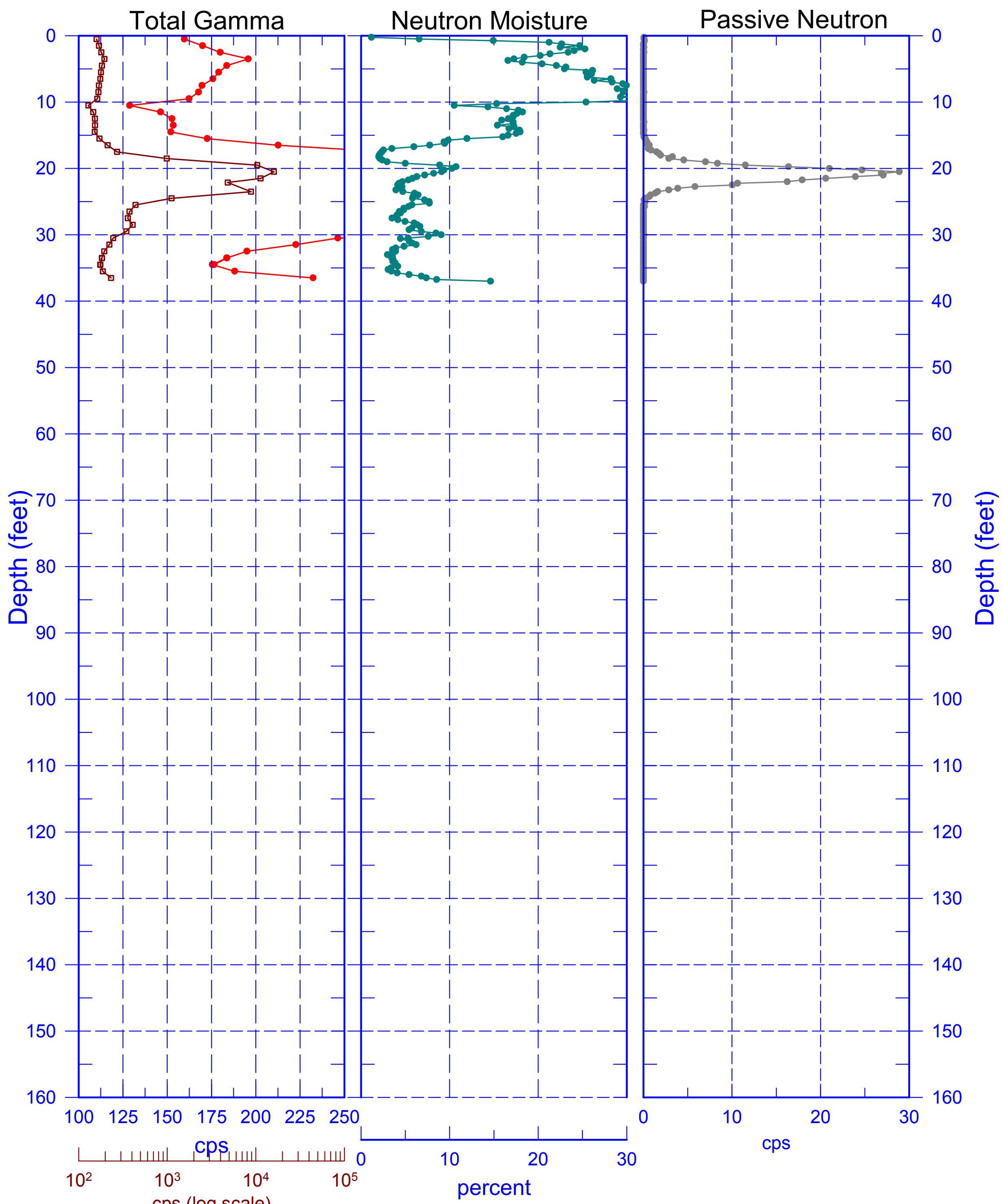
Total Gamma, Neutron Moisture & Passive Neutron



Zero reference = Ground Surface

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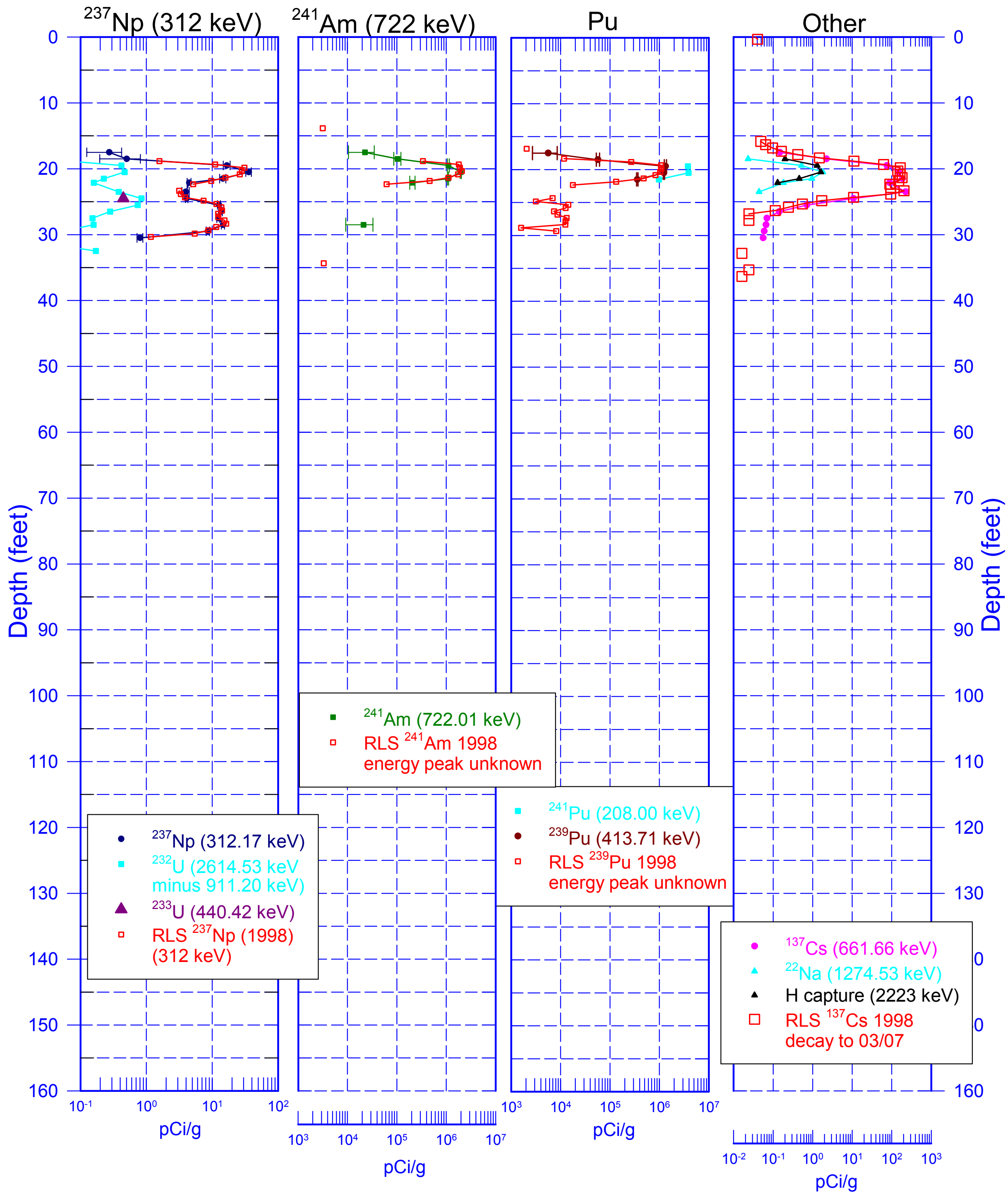
Manmade Radionuclide Comparison (SGLS/RLS)



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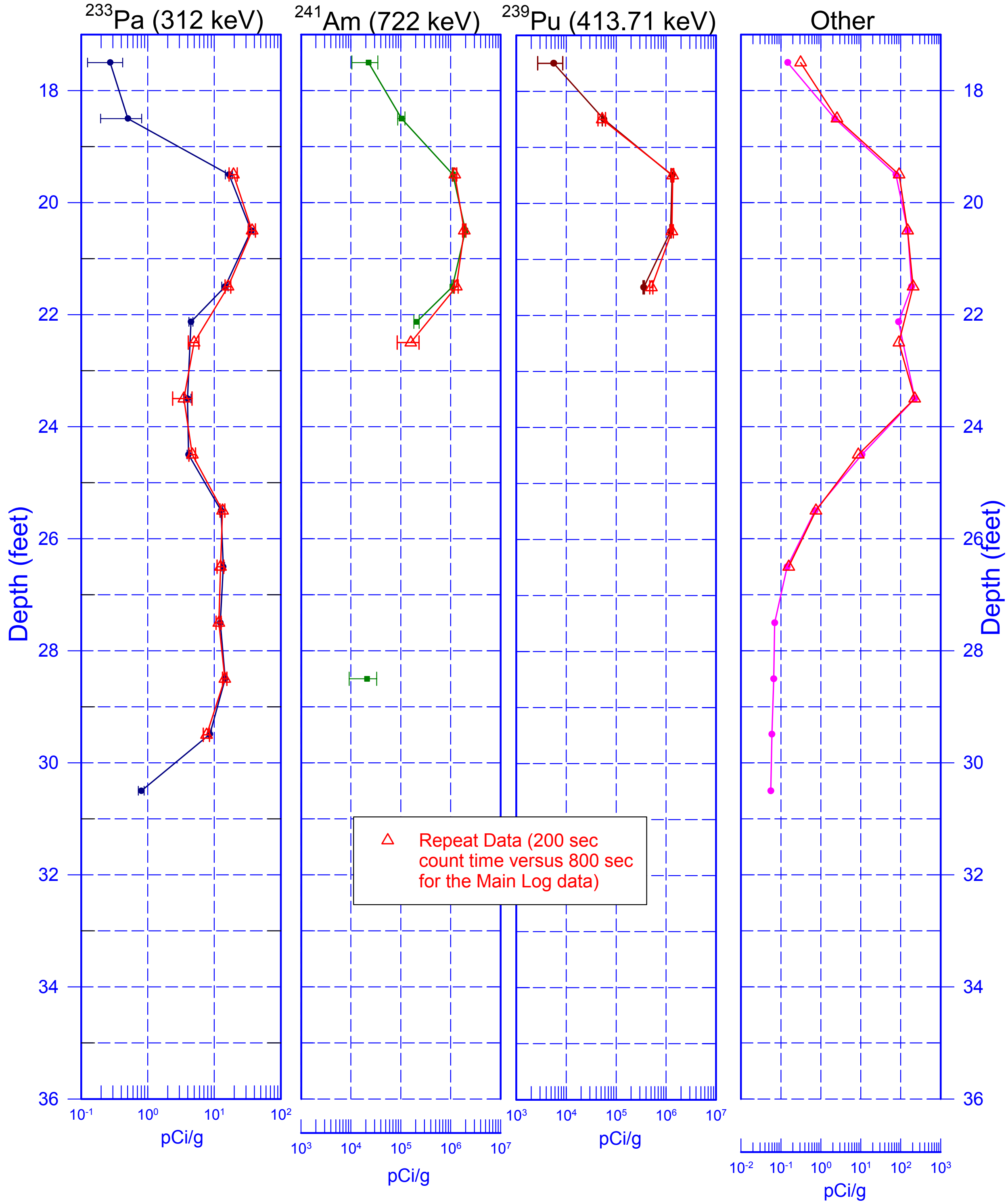
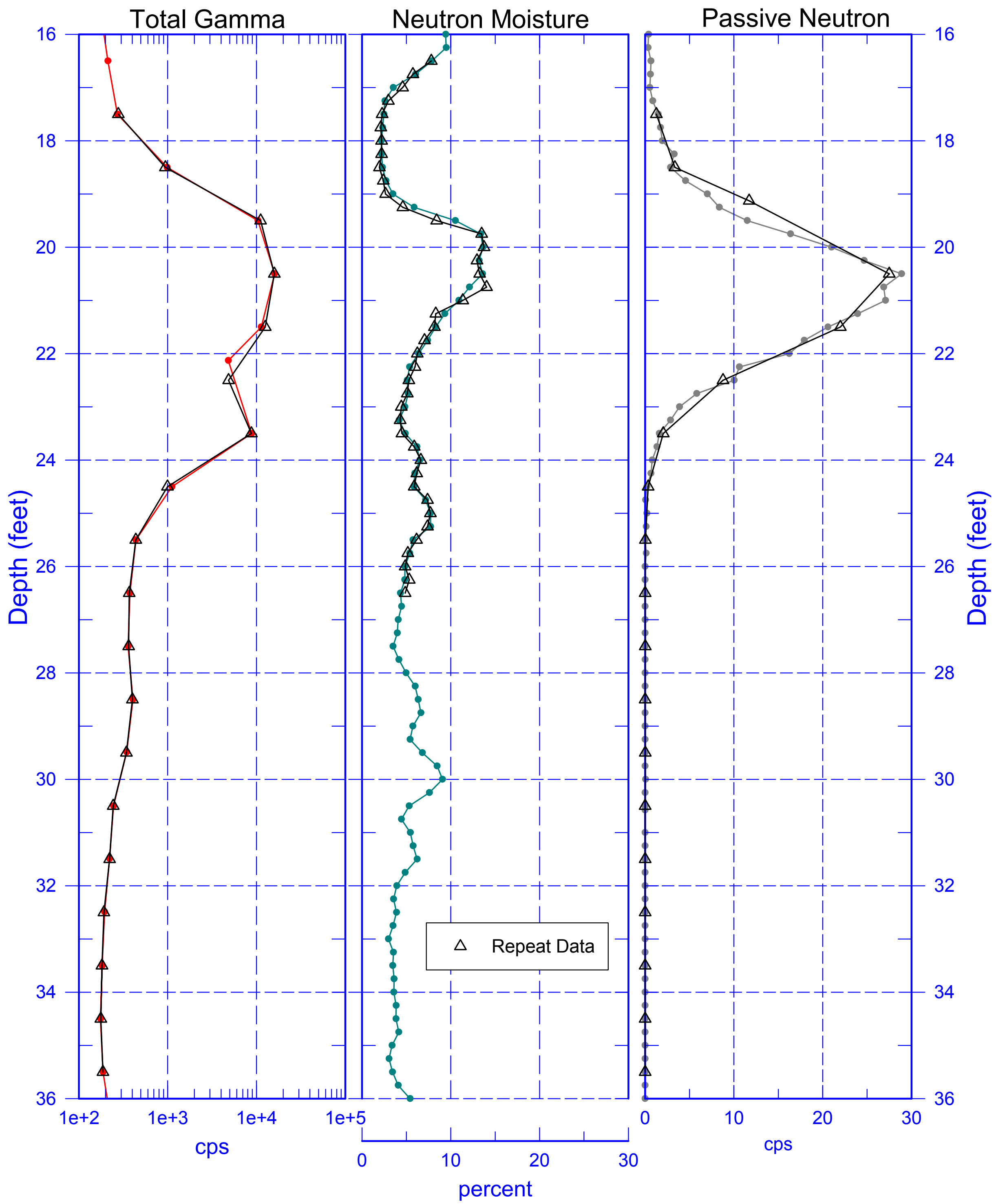
Repeat of Manmade Radionuclides



Zero Reference = Ground Surface

299-W18-182 (A7664)
Repeat of Total Gamma, Neutron Moisture & PN



Zero reference = Ground Surface